

## Self-reported eating traits

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DOI:

[10.1016/j.appet.2015.07.006](https://doi.org/10.1016/j.appet.2015.07.006)

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*Document Version*

Peer reviewed version

*Citation for published version (Harvard):*

Price, M, Higgs, S & Lee, M 2015, 'Self-reported eating traits: Underlying components of food responsiveness and dietary restriction are positively related to BMI', *Appetite*, vol. 95, pp. 203-210.  
<https://doi.org/10.1016/j.appet.2015.07.006>

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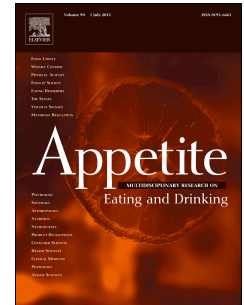
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# Accepted Manuscript

Self-reported eating traits: underlying components of food responsivity and dietary restriction are positively related to BMI

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PII: S0195-6663(15)00323-2

DOI: [10.1016/j.appet.2015.07.006](https://doi.org/10.1016/j.appet.2015.07.006)

Reference: APPET 2628

To appear in: *Appetite*

Received Date: 1 April 2015

Revised Date: 4 July 2015

Accepted Date: 6 July 2015

Please cite this article as: Price M., Higgs S. & Lee M., Self-reported eating traits: underlying components of food responsivity and dietary restriction are positively related to BMI, *Appetite* (2015), doi: 10.1016/j.appet.2015.07.006.

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Title: Self-reported eating traits: underlying components of food responsiveness and dietary restriction are positively related to BMI

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*Abstract*

Self-report measures of dietary restraint, disinhibited eating, hedonic response to food and loss of control over eating have been related to overeating, overweight and obesity. Impulsivity has emerged as a potential moderator in this relationship. However, the exact relationship between these measures and obesity is poorly defined. Self-report data was collected from a student and community based sample (N=496) of males (N=104) and females, with a wide age (18-73yrs; M=27.41) and BMI (15.3-43.6; M=24.2) range. Principle component analysis was used to explore the underlying structure of the sub-scales from a variety of eating behaviour questionnaires. Two emergent components relating to 'dietary restriction' and 'food reward responsivity' were supported in the analysis. Food reward responsivity component scores positively predicted BMI, but this relationship was moderated by impulsiveness. Dietary restriction component scores positively predicted BMI but were not moderated by impulsiveness. These findings suggest that frequently used eating behaviour measures can be reduced to two underlying components. Food reward responsivity positively predicts BMI, but only when impulsiveness is also high, supporting a dual-system approach where both bottom-up food reward drives and top-down impulse control are associated with overweight and obesity. Dietary restriction is an independent, positive predictor of BMI and is likely to be reflecting repeated unsuccessful attempts at weight control.

*Keywords:* impulsivity, obesity, reward, restraint

*Introduction:*

A variety of self-report measures of eating behaviour have been developed to quantify the extent to which an individual is 'drawn' to food in the environment and finds the consumption of food rewarding. Several dimensions of eating motivation have been identified across the most commonly used self-report questionnaires (The Dutch Eating Behaviour Questionnaire (DEBQ) dietary restraint, external and emotional eating sub-scales (van Strien, Frijter, Bergers and Defares, 1986); the Three Factor Eating Questionnaire (TFEQ: Short version, Karlsson, Persson, Sjostrom, and Sullivan, 2000); The Power of Food Scale (PFS; Lowe, Butryn, Didie, Annunziato, Thomas, Crerand et al., 2009); The Emotional Eating Scale (EES; Arnow, Kenardy and Agras, 1995); and, the Yale Food Addiction Scale (YFAS; Gearhardt, Corbin and Brownell, 2009). These include disinhibited eating in response to a negative moods and external food cues, restraining dietary intake in order to maintain or lose weight, the hedonic responses to food in the environment or once tasted, and the loss of control over intake and experience of problematic and addictive-like eating episodes.

French, Epstein, Jeffery, Blundell and Wardle (2012) reviewed a number of eating behaviour dimensions, such as food responsiveness and eating disinhibition, in relation to overeating and overweight. However, as these dimensions have been developed independently from one another, little research has explored the extent to which they overlap or if they differentially predict obesity. The exact nature of each of these eating behaviour dimensions therefore remains unclear (Vainik, Dagher, Dube and Fellows, 2013) and recent evidence suggests that they may overlap quite significantly, given that eating behaviour measures are often highly correlated (e.g. Elfhag and Morey, 2008; Vainik, Neseliler, Konstabel, Fellows and Dagher, 2015). Vainik and colleagues (2015) have shown that a number of self-report eating behaviour questionnaires represent a single common factor. The factor was labelled

‘uncontrolled eating’ and included questionnaires that varied in the severity of uncontrolled eating that was captured. For example, the PFS was deemed as capturing a moderate lack of control, but a binge-eating measure as capturing more severe lack of control over eating. This suggests that a number of commonly used questionnaires may be measuring a single trait that varies in severity. However, Vainik and colleagues did not include males in the analysis and omitted dietary restraint scales and the YFAS.

The YFAS scale is based on substance use criteria as defined in DSM-IV (APA, 2000) and can return a dichotomous ‘food addiction’ diagnosis, or a symptom count of the number of addiction criteria met (e.g. withdrawal, tolerance, dependence). However, the notion of ‘food addiction’ is contentious (Ziaudeen and Fletcher, 2013) and the scale may be more practically viewed as a useful tool for identifying a distinct group of people with tendencies to experience cravings and ‘lose control’ around food and become overweight. Davis, Curtis, Levitan, Carter, Kaplan and Kennedy (2011) found that scores on the YFAS were related to impulsivity, food craving and the tendency to ‘self-soothe’ with food in response to negative mood. In this sense it is likely to capture similar dimensions to the other measures described here but also the more severe forms of ‘uncontrolled eating’ as proposed by Vainik and colleagues previously.

As well as a lack of clarity about the precise nature of the eating behaviours captured by multiple questionnaires, there is a lack of consistency in their relationship with obesity and overweight. Many studies report a positive relationship between these measures and consumption of palatable foods in the lab but fail to report any relationship with BMI (Westenhoefer, Broeckmann, Munch, & Pudel, 1994; Haynes, Lee & Yeomans, 2003; Ouwens, van Strien and van der Staak, 2003; Fay and Finlayson, 2011). Studies that report relationships with BMI vary in outcome. Schubert and Randler (2008) found that BMI correlated with TFEQ disinhibition scores but not restraint. Conversely, Snoek, Engels, van

Strien and Otten, (2013) found that highly restrained adolescents, classified using the DEBQ, had a significantly higher chance of being in the higher BMI trajectories, but that external and emotional eating scale scores were unrelated to BMI. Bellisle, Clement, Le Barzic, Le Gall, Guy-Grand, and Basdevant (2004) in a study of 2509 adults, showed that disinhibition positively predicted BMI in men and women, but that restraint only predicted BMI in men. Geliebter and Aversa (2003) found that emotional eating in response to negative emotions was higher in overweight individuals versus lean individuals and Yeomans and Coughlan (2009) found that BMI was significantly higher in those with high versus low disinhibited eating scores. However, palatable food intake was modified by dietary restraint scores. PFS scores have not been shown to be related to BMI (Appelhans, Woolfe, Pagoto, Schneider, Whited and Liberman, 2011; Vainik, Neseliler, Konstabel, Fellows and Dagher, 2015), whereas YFAS scores have been related to BMI in a large sample of men and women (Pedram, Wadden, Amini, Gulliver, Randell, Cahill et al., 2013).

Given that eating behaviour is likely to be influenced by both bottom-up food reward drives and top-down impulse control, inconsistencies in the literature relating self-report eating behaviour and BMI may be the result of a failure to consider the role of impulsivity (Gerlach, Herpetz and Loeber, 2015; van der Laan and Smeets, 2015). Indeed, research has found that the relationship between the standard eating behaviour measures and overweight is often moderated by impulsivity (Jansen, Nederkoorn, van Baak, Kierse, Guerrieri and Havermans, 2009). Food reward responsive individuals, as measured by the Power of Food scale (PFS; Lowe, Butryn, Didie, Annunziato, Thomas, Crerand et al., 2009) are reported to overeat only when they are also score highly on impulsivity assessed by a delay discounting task (Appelhans, Woolfe, Pagoto, Schneider, Whited and Liberman, 2011). Emery, King, Fischer and Davis (2013) found that high levels of dietary restraint predicted higher binge eating tendencies in college students, but that impulsivity moderated the effect of restraint, such that

high levels of urgency impulsivity ('acting without thinking': UPPS; Whiteside and Lynam, 2001) predicted high binge eating tendencies across all levels of restraint. Murphy, Stojek and Mackillop (2014) have recently reported that the urgency sub-scale of the UPPS predicted BMI through the mediating influence of scores on the Yale Food Addiction Scale (YFAS; Gearhardt, Corbin and Brownell, 2009). Furthermore, Nasser, Gluck & Geliebter (2004) reported that scores on the motor impulsivity ('acting without thinking') sub-scale of the Barratt Impulsiveness Scale (BIS 11; Patton, Stanford and Barratt, 1995) were significantly higher in patients with binge-eating disorder compared to controls. Therefore, the tendency to be impulsive is likely to play a crucial role in moderating the relationship between self-reported food reward drives and actual over eating. Impulsivity is a multi-faceted construct and the tendency to 'act without thinking' as captured by both the urgency sub-scale of the UPPS and the motor impulsiveness sub-scale of the BIS11 appears to be particularly important. French and colleagues (2012) reviewed much of the literature concerned with eating behaviour and impulsivity and conclude that it is essential to clarify whether impulsivity confers its own risk for obesity or whether this risk is limited to those who are highly motivated by food.

A better understanding of the relationship between psychological variables and obesity is vital if more effective behavioural interventions are to be developed. As yet, there has been no examination of a variety of eating behaviour measures, including YFAS and restraint scores along with indices of impulsiveness in a single study, leaving a significant gap in current knowledge. Therefore, the aim of the current study was to collect self-report data from a student and community based sample of men and women across a wide age and BMI range. The most commonly used eating behaviour measures (EES, TFEQ, DEBQ, PFS, YFAS) were included, as well as a measure of impulsiveness (BIS 11), to clarify the relationship between these measures and BMI. Previous research suggests eating behaviour



measures are often highly correlated and load onto one underlying component relating to a loss of control over eating in response to environmental and emotional cues (Vainik et al., 2015). However we also include measures of dietary restraint and suggest that this will result in the questionnaires loading onto two common underlying components relating to 1) a tendency to be responsive to food reward (food reward responsivity) and 2) a tendency to restrict intake in order to lose or maintain weight (dietary restriction). Therefore, our first aim was to conduct a principal components analysis to examine the underlying component structure of the commonly used eating behaviour questionnaires. Our second aim was to examine the moderating role of impulsiveness in the relationship between these eating behaviour components and BMI. It was hypothesised that the component scores would positively predict BMI, but only in those with high impulsiveness scores.

## *Method*

### *Participants and procedures*

Participants were recruited from the student populations at Swansea University, and the University of Birmingham, as well as from the wider community (N=496). This study was granted departmental ethical approval by the Swansea University, Department of Psychology Research Ethics Committee. The demographic and questionnaire items were presented to participants online using Survey Monkey (Palo Alto, California, USA). Participants either attended the lab to fill in the questionnaires (if they were students receiving course credit) or accessed the questionnaires remotely (in response to a call for community volunteers). Demographic information including gender, age, height and weight were recorded in the lab where relevant, but was otherwise self-reported. BMI for each participant was calculated using the standard formula ( $\text{kg/m}^2$ ). Self-reported BMI is found to be highly correlated with measured BMI (Vainik et al., 2015) in young (Pursey, Burrows, Stanwell and Collins, 2014),

middle-age and elderly groups (Ng, Korda, Clements, Latz, Bauman, Liu et al., 2011) and so the data was deemed appropriate to combine. However, given that self-reported versus measured height is often overestimated and weight underestimated (Ng et al., 2011), the method of measurement (self-report versus measured) was entered as a dichotomous covariable in the tested model, however this made no difference to the outcome and so original outcomes from the combined sample are reported. BMI data was not available for 24 participants, therefore any analysis including BMI comprised 471 participants. See Table 1 for sample characteristics.

### *Measures*

The following questionnaires were employed in the current study. Means, standard deviations and internal reliability estimates for the current population are listed in Table 1.

*The Power of Food Scale (PFS: Short version: Lowe, Butryn, Didie, Annunziato, Thomas, Crerand et al., 2009)*

The PFS is a widely used questionnaire with 15 items pertaining to a participants' appetite for palatable food. Each item is rated on a scale of 1-5, ranging from 'don't agree' at all to 'strongly agree'. This questionnaire was included to measure appetite at three levels; where food is 1) available (e.g. "It seems like I have food on my mind a lot"); 2) present (e.g. If I see or smell a food I like, I get powerful urge to have some"; or, 3) tasted (e.g. "When I eat delicious food I focus a lot on how good it tastes"). A sum-score is obtained for each sub-scale and then averaged, with higher scores indicating a greater appetite for palatable food.

*The Emotional Eating Scale (EES; Arnow, Kenardy and Agras, 1995)*

The EES is used to measure overeating in response to emotional stimuli. It is a 25 item adjective checklist that asks participants to rate, on a 5 point scale, the degree to which each

mood state generates a desire to overeat, has no effect, or a desire to under eat. It has three sub-scales; anger/frustration (e.g. resentful, discouraged, irritated), anxiety (e.g. shaky, uneasy, on edge) and depression (e.g. sad, worn out, bored). A total sum-score for each sub-scale is then calculated with higher scores indicating greater tendencies to eat in response to negative emotions.

*The Three Factor Eating questionnaire (TFEQ-18R short version; Karlsson, Persson, Sjostrom, and Sullivan, 2000):* The TFEQ-18R measures cognitive and behavioural components of eating and has three sub-scales. The cognitive restraint sub-scale is designed to measure the tendency to restrict dietary intake in order to control weight and has six items (e.g. “I deliberately take small helpings as a means of controlling my weight”). The uncontrolled eating sub-scale is designed to measure the extent of control over eating behaviour (e.g. “Sometimes when I start eating I just can’t seem to stop”) and has nine items. The emotional eating sub-scale is designed to measure the tendency to eat in response to negative emotions (e.g. “When I feel blue, I often overeat”) and has three items. The short version was selected as it has been shown to be a valid measure of eating behaviour (Keranen, Savolainen, Reponen, Kujari, Lindeman, Bloigu and Laitinen, 2009; Keranen, Strengell, Savolainen and Laitinen, 2011) and in order to reduce fatigue given the large number of questionnaires included in the study. Scores are calculated for each sub-scale as a proportion of the highest possible value and expressed on a scale of 0-100 and higher scores indicating greater tendencies to restrain, lose control over eating or eat when in a negative mood respectively.

*The Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien, Frijter, Bergers and Defares, 1986):* The DEBQ measure has 33 items in total and is comprised of three sub-scales. The dietary restraint sub-scale has ten items relating to restrained eating (e.g. “When you have put on weight, do you eat less than you usually do?”). The external eating sub-scale

has ten items relating to the presence of food cues in the environment (e.g. “If you see others eat do you have the desire to eat?”). The emotional eating sub-scale has thirteen items and relates to the tendency to eat in response to negative emotions (e.g. “Do you have the desire to eat when someone lets you down?”). A score is obtained for each sub-scale by obtaining an average from the sum-scores, with higher scores indicating greater tendencies to restrain, eat in response to external cues or when in a negative mood respectively

*The Barratt Impulsiveness Scale (BIS 11; Patton, Stanford and Barratt, 1995)*

The BIS11 is a 30 item questionnaire that is widely used to measure impulsivity and is structured to assess long-term patterns of behaviour. It is used as a measure of trait impulsiveness and is comprised of three second order (attention, motor and non-planning impulsivity) sub-scales to measure different facets of impulsiveness. Motor impulsiveness measures the tendency to act without thinking (e.g. I do things without thinking”), attentional impulsiveness is defined as an inability to focus attention or concentrate (e.g. “I have racing thoughts”) and non-planning impulsiveness is defined as a lack of ‘futuring’ or forethought (e.g. “I am more interested in the present than the future”). A sum-score for each sub-scale and an overall total is then calculated with higher scores indicating greater impulsiveness.

*The Yale Food Addiction Scale (YFAS; Gearhardt, Corbin and Brownell, 2009)*

The YFAS is a 25 item eating behaviour measure adapted from the DSM-IV criteria (APA, 2000) for substance dependence. For example, “Substance is taken in larger amount and for longer period than intended”; “Persistent desire or repeated unsuccessful attempts to quit”; “Use continues despite knowledge of adverse consequences”). It can return a dichotomous outcome for a ‘food addiction’ diagnosis or not, but can also return a continuous variable score for the number of diagnostic criteria met ranging between 0-7, with higher scores indicating a larger number of DSMIV criteria met and a greater tendency to lose control over

ones eating behaviour. The symptom count is often employed in community samples as ‘food addiction’ diagnosis has relatively low prevalence in this population (Gearhardt et al., 2009). For the current analysis, a continuous sum-score for the active items (n=3 items are ‘primer’ items and not intended to be included in the total score) was calculated instead, in order for the scale to be directly comparable to the other scales. This is supported by the finding that the YFAS is measuring a single trait and that most items load onto that factor (Meule, Heckel and Kubler, 2012) and that in the current sample, the symptom count has only moderate internal reliability whereas the sum-score total has high internal reliability (see Table 1). Correlation coefficients for both the symptom count and sum-scores are presented in Table 2 for reference.

#### *Data Analysis*

It is unknown whether the current measures can be represented by a single dimension and the exact nature of the underlying trait is unclear, therefore Principal Component Analysis (PCA) was deemed more appropriate than a factor analytic technique (which presumes a single underlying latent variable; Fabrigar, MacCallum, Wegener and Straham, 1999). Oblique (Promax) rotation was employed, as previous research suggests that the components may be related. The number of components to extract was determined by examination of scree plot observation and calculation of parallel analysis and Velicer’s MAP test. Convergence of component extraction using these techniques is shown to be more reliable than using the eigenvalues >1 rule (Kaiser, 1960; O’Connor, 2000). Component scores were produced based on regression method, and used in subsequent analysis.

The PROCESS macro (Hayes, 2012) was employed to test the proposed moderating models. All calculations were performed in SPSS 20.0 and effect sizes were calculated using G\*Power (Faul, Erdfelder, Lang and Buchner, 2007).

## Results

### Principle Component Analysis

All eating behaviour sub-scale scores were entered into a correlation matrix to observe the inter-correlations between the questionnaires (see Table 2). High correlations between many of the sub-scales supported the need for the subsequent principle component analysis. In addition, BIS 11 sub-scale and total scores and BMI were also entered into the matrix for reference purposes.

Principle components analysis (PCA) for the eating behaviour measures supported a two-component outcome: The scree-plot inflection point (Stevens, 2002) favoured two components as did parallel analysis and the Velicer's MAP test (O'Connor, 2000). Consequently fixing the number of components to two resulted in the sub-scales loading convincingly either on to a component reflecting: 1) reduced control over eating in response to external food cues and internal emotional states ('Food Reward Responsivity'; FRR); or 2) the tendency to restrict intake in order to control weight ('Dietary Restriction'; DR) (see Table 3). These components were unrelated ( $r=.06$ ;  $p>.05$ ).

### Model testing:

It was predicted that FRR and DR component scores would predict BMI, but would be moderated by impulsiveness. Age and gender were both positively correlated with BMI, with males and older participants being more likely to have a higher BMI ( $p<0.01$ ) and so were included as covariates in all analyses. BMI and age were significantly skewed ( $z_{\text{skewness}} > 2$ ) and the model was also run with log transformed data, this corrected the skew but did not change the outcome and so the original analysis is reported here for descriptive clarity.

The proposed models were tested using PROCESS moderation model 1 (Hayes, 2012), with FRR or DR component scores as the predictor variable, BIS11 total impulsiveness scores as the moderating variable and BMI as the outcome variable in two separate models. These were mean centred prior to analysis as recommended by Howell (2013).

#### *FRR Model:*

The overall model was significant for predicting BMI ( $F(5,465)=14.8$ ;  $p<.0001$ ;  $R^2=.14$ ;  $f^2=.08$ ). Table 4 shows the model output. FRR significantly predicts BMI, whereas the BIS11 total scores do not. However, there is a significant interaction between FRR and BIS11 scores. The Johnson-Neyman technique (Johnson and Fay, 1950) was used to probe the interaction and identify the values on the continuum of BIS11 at which point the effect of FRR transitions between statistically significant and non-significant at the 0.05 level. This showed that at BIS11 total scores above 61.9, FRR significantly predicts BMI, but below this point FRR is not a significant predictor of BMI. When values are plotted at one standard deviation above and below the mean (see Figure 1), it can be seen that high impulsiveness and high FRR predict significantly higher BMI than low impulsiveness and high FRR ( $p=.03$ ). In addition, high FRR and high impulsiveness predict significantly higher BMI than high impulsiveness and low FRR ( $p<.0001$ ). When impulsiveness is low, scores on the FRR do not predict BMI and when FRR is low, impulsiveness does not predict BMI ( $p>.05$ ).

#### *DR Model:*

The overall model was significant for predicting BMI ( $F(5,465)=15.1$ ;  $R^2=.14$ ;  $p<.0001$ ;  $f^2=.08$ ). Table 5 shows the model output. DR and BIS11 scores predict BMI independently, but do not interact to predict BMI (see figure 2).

Both models were also tested with the second order sub-scales of the BIS11 in place of the total scores. Only the motor impulsiveness sub-scale was a significant moderator of FRR in

predicting BMI ( $t(465)=2.16$ ;  $p=.03$ ), with FRR predicting BMI only at higher levels of motor impulsiveness. The Johnson-Neyman technique showed that FRR only predicted BMI when motor impulsivity scores were 21.9 or above. For the model predicting DR, as with the total BIS11 score, none of the sub-scales were significant moderators ( $p>.05$ ).

#### *Discussion:*

In an attempt to understand the complex relationship between self-reported eating behaviour and BMI, we conducted a study in which a student and community based sample of males and females with a wide age and BMI range, completed a broad selection of eating behaviour questionnaires. The scores were first entered into a dimension reduction procedure using Principle Components Analysis (PCA). Two underlying components of 'food reward responsivity' (FRR) and 'dietary restriction' (DR) emerged, demonstrating for the first time that an array of standard eating behaviour measures are tapping into similar constructs. Vainik and colleagues (2015) have very recently shown that a single underlying factor of 'uncontrolled eating', which varies in severity, underlies several self-report questionnaires of eating behaviour and predicted BMI in two female samples. However, the authors noted that the YFAS was not included, and in addition, the study did not include measures of dietary restraint. We therefore confirm the previous finding that a single factor underlies many self-report measures of eating behaviour but extend them to a wider array of eating behaviour questionnaires with responses from both males and females with a broad age and BMI range. The questionnaires included here and that loaded onto the FRR component, were designed to measure a range of eating behaviours. These include the hedonic response to food, disinhibited eating, uncontrolled eating, emotional eating and loss of control over eating. These concepts have been often segregated in the literature and it has been questioned whether this is necessary given the possibility of conceptual overlap (French et al., 2012).



Current findings indicate that these concepts do indeed overlap and may be measuring a common underlying concept that is important in predicting BMI. All of the sub-scales include items that relate to losing control over eating as a consequence of internal, emotional or external, food cues. In this sense they can be thought of as consistent with Vainik and colleagues' concept of 'uncontrolled eating'. However, the questionnaires also contain a number of items that pertain to food cue responsiveness and enjoyment of food which do not necessarily reflect a loss of control over eating behaviour. Future work combining all of the questionnaires from both studies at an item level would be of use now to determine if the FRR and 'uncontrolled eating' variables are indeed overlapping, and which items are best able to capture the behaviours that predict BMI.

It was hypothesised that the tendency to be drawn to food and lose control or restrict intake would only manifest in a higher BMI if top-down control over these urges was low (Gerlach, Herpetz and Loeber, 2015; van der Laan and Smeets, 2015). Indeed, FRR only predicted BMI at higher levels of impulsiveness, as measured by the BIS11. This is consistent with previous findings that the relationship between the standard eating behaviour measures and overweight is often moderated by impulsivity (e.g. Jansen, Nederkoorn, van Baak, Kierse, Guerrieri and Havermans, 2009). These data support a dual-system approach to overeating, where both bottom-up reward drives and top-down control over impulses are associated with BMI. The finding that only the motor impulsiveness sub-scale moderated FRR scores suggests that it is the 'acting without thinking' aspect of impulsiveness that is particularly important in this relationship. Indeed, Nasser, Gluck & Geliebter (2004) reported that scores on the motor impulsivity were significantly higher in patients with binge-eating disorder compared to controls.

Previously, dietary restriction tendencies have been shown to be protective in low impulsive individuals, but unsuccessful in highly impulsive individuals (Jansen et al., 2009; Emery et

al., 2013). In the present sample, the interaction between restraint and impulsivity did not reach significance. Dietary restriction emerged as an independent predictor of BMI where higher levels of dietary restraint were associated with higher BMI. This supports the view that dietary restrainers purposefully restrict caloric intake in order to prevent weight gain but that this is permeated by periods of over eating that can lead to weight gain (Herman and Polivy, 1980). Papies, Stroebe and Aarts (2008) have shown that individuals who are overweight and are high dietary restrainers, exhibit unsuccessful dieting behaviour, where goals of hedonic food enjoyment frequently override weight loss goals in the presence of tasty food cues. This may explain the pattern of our findings and suggests that high dietary restriction goals may be the consequence of being overweight and are not necessarily successful. In addition, this study tested men and women from student and community populations with a wide range of age and BMI, whereas previous studies have primarily reported findings from narrow samples of mainly female participants, adolescents or children. It would therefore be useful now to explore the role of dietary restraint in different populations to investigate whether the interaction between impulsivity and restraint is limited to certain age or gender groups.

A few limitations to the current study must be noted. First, the study is based on cross-sectional, self-report data and ideally the model would benefit from replication in experimentally controlled conditions of food intake and weight gain over time. However, self-report designs allow for larger samples and greater generalisation of findings and so were deemed appropriate for the aims of this study. Second, although the BMI range was relatively wide, it would be useful to include data from the more severe obesity classes to investigate how this pattern of behaviour applies to these groups. Third, although every effort was made to collect data from a representative group of male participants, the female to male ratio was still about 3:1 and any future research would benefit from applying this model to large male

samples in order to test its generalizability to both men and women. Having said this, gender was controlled for in the analysis and the diverse age range of the sample allows for a model that may be applied to a larger section of the population than standard student based data. Last, the model was tested on the same sample on whom the PCA was conducted and so replication of the findings in a separate sample would confirm reliability.

### *Conclusions*

This is the first model to assess the relationships between several measures of eating behaviour, general impulsivity and BMI in a sample of males and females with wide ranging age and adiposity. These data suggest that a variety of questionnaires load onto a common component reflecting the tendency to be responsive to food reward, therefore the cross-comparison of previous studies using any of these eating behaviour measures is supported. In addition to this, these data show that impulsiveness is important in reducing control over food reward responsivity. In particular, the tendency to act without thinking (motor impulsiveness) moderates the relationship between food responsivity and BMI. Therefore, both high 'bottom-up' food reward drives and reduced 'top-down' control over impulsive urges are associated with overweight and a dual-system approach to self-control is supported by these findings. The BIS 11 is a viable candidate for profiling those food responsive individuals who are most at risk from weight gain and a promising target for intervention. Research now needs to look to finding ways of reducing impulsivity in those vulnerable to overweight. Indeed, interventions based on training of response inhibition (e.g. Houben and Jansen, 2011) and priming higher level construal thinking (Price, Higgs and Lee, under review) show promise in aiding reduced consumption and, as supported by this model, may be more effective than dietary restriction methods alone.

### *References*

- 409 American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental*  
 410 *disorders: DSM-IV-TR*. Washington, DC: American Psychiatric Association
- 411 Appelhans, B.M., Woolfe, K., Pagoto, S.L., Schneider, K., Whited, M.C. & Leiberhan, R.  
 412 (2011). Inhibiting food reward: Delay discounting, food reward sensitivity, and  
 413 palatable food intake in overweight and obese women. *Obesity*, 57: 1-8.
- 414 Arnow, B., Kenardy, J. & Agras, W.S. (1995). The Emotional Eating Scale: The development  
 415 of a measure to assess coping with negative affect by eating. *International Journal of*  
 416 *Eating Disorders*, 18 (1), 79-90.
- 417 Burger, K.S. & Stice, E. (2011). Relation of dietary restraint scores to activation of reward-  
 418 related brain regions in response to food intake, anticipated intake, and food pictures.  
 419 *Neuroimage*, 233-239.
- 420 Burton, P., Smit, H.J., Lightowler, H.J. (2007). The influence of restrained and external  
 421 eating patterns on overeating. *Appetite*, 49, 191-197.
- 422 Davis, C. (2013). From passive overeating to food addiction: A spectrum of compulsion and  
 423 severity. *ISRN Obesity*, e435027.
- 424 Davis, C., Curtis, C., Levitan, R.D., Carter, J.C., Kaplan, R.S. & Kennedy, J.L. (2011).  
 425 Evidence that 'food addiction' is a valid phenotype of obesity. *Appetite*, 57, 711-717.
- 426 Elfhag, K. and Morey, L.C. (2008). Personality traits and eating behaviour in the obese: Poor  
 427 self-control in emotional and external eating but personality assets in restrained eating.  
 428 *Eating Behaviours*, 9, 285-293.

- Emery, R.L., King, K.M., Fischer, S.F. & Davis, K.R. (2013). The moderating role of negative urgency on the prospective association between dietary restraint and binge eating. *Appetite*, 71, 113-119.
- Fabrigar, L.R., MacCallum, R.C., Wegener, D.T., and Straham, E.J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods*, 4, 272-299.
- Faul, F., Erdfelder, E., Lang, A-G. & Buchner, A. (2007). G\*Power 3: A flexible statistical power analysis program for the social, behavioural and biomedical sciences. *Behavior Research Methods*, 39(2): 175-191.
- Fay, S.H. and Finlayson, G. (2011). Negative-affect induced food intake in non-dieting women is reward driven and associated with restrained-disinhibited eating sub-type. *Appetite*, 56, 682-688.
- Field, A. (2009). *Discovering Statistics Using SPSS*. (3<sup>rd</sup> Ed.). London: Sage Publications Ltd.
- Forman, E.M., Hoffman, K.L., McGrath, K.B., Herbert, J.D., Brandsma, L.L. & Lowe, M.R. (2007). A comparison of acceptance- and control-based strategies for coping with food cravings: An analog study. *Behaviour Research and Therapy*, 45, 2372-2386.
- French, S.A., Epstein, L.H., Jeffery, R.W., Blundell, J.E. and Wardle, J. (2012). Eating behaviour dimensions. Associations with energy intake and body weight: A review. *Appetite*, 541-549.
- Gearhardt, A.N., Corbin, W.R. & Brownell, K.D. (2009). Preliminary validation of the Yale Food Addiction Scale. *Appetite*, 52: 430-436.

- 451 Gerlach, G., Herpetz, S., & Loeber, S. (2015). Personality traits and obesity: a systematic  
452 review. *Obesity Reviews*, 16, 32-63.
- 453 Hayes, A.F. (2012). PROCESS: A versatile computational tool for observed variable  
454 mediation, moderation and conditional process modelling [White paper]. Retrieved  
455 from <http://www.afhayes.com/public/process2012.pdf>
- 456 Haynes, C., Lee, M.D. & Yeomans, M.R. (2003). Interactive effects of stress, dietary  
457 restraint, and disinhibition on appetite. *Eating Behaviours*, 4, 369-383.
- 458 Herman, C.P. & Polivy, J. (1980). Restrained Eating. In A.J. Stunkard (Ed.), *Obesity* (pp.  
459 208-205). Philadelphia: W.B.Sanders.
- 460 Houben, K. and Jansen, A. (2011). Training inhibitory control: A recipe for resisting sweet  
461 temptations. *Appetite*, 56, 345-349.
- 462 Howell, D.C. (2013). *Statistical Methods for Psychology* (8<sup>th</sup> Ed.). Wadsworth: Cengage  
463 Learning.
- 464 Jansen, A., Nederkoorn, C., van Baak, L., Kierse, C., Guerrieri, R. and Havermans, R.  
465 (2009). High-restrained eaters only overeat when they are also impulsive. *Behaviour*  
466 *Research and Therapy*, 47, 105-110.
- 467 Johnson, P.O. and Fay, L.C. (1950). The Johnson-Neyman Technique, its theory and  
468 application. *Psychometrika*, 15(4), 349-367.
- 469 Kaiser, H.F. (1960). The application of electronic computers to factor analysis. *Educational*  
470 *and Psychological Measurement*, 20, 141-151.
- 471 Karlsson, J., Persson, L-O., Sjostrom, L. & Sullivan, M. (2000). Psychometric properties and  
472 factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and

women. Results for the Swedish Obese Subjects (SOS) study. *International Journal of Obesity*, 24, 1715-1725.

Keranen, A-M., Savolainen, M.J., Reponen, A.H., Kujari, M-L., Lindeman, S.M., Bloigu, R.S. and Laitinen, J.H. (2009). The effect of eating behaviour on weight loss and maintenance during a lifestyle intervention. *Preventive Medicine*, 49, 32-38.

Keranen, A-M., Strengell, K., Savolainen, M.J. and Laitinen, J.H. (2011). Effect of weight loss intervention on the association between eating behaviour measured by TFEQ-18 and dietary intake in adults. *Appetite*, 56, 156-162.

Lowe, M.R., Butryn, M.L., Didie, E.R., Annunziato, R.A., Thomas, J.G., Crerand, C.E. et al (2009). The Power of Food Scale. A new measure of the psychological influence of the food environment. *Appetite*, 53: 114-118.

Meule, A. (2013). Impulsivity and overeating: a close look at the Barratt Impulsiveness Scale. *Frontiers in Psychology*, 4, 177, 1-4.

Meule, A., Heckel, D., and Kubler, A. (2012). Factor structure and item analysis of the Yale Food Addiction Scale in obese candidates for bariatric surgery. *European Eating Disorders Review*, 20, 419-422.

Murphy, C.M., Stojek, M.K. & Mackillop, J. (2014). Interrelationships among impulsive personality traits, food addiction, and body mass index. *Appetite*, 73, 45-50.

Nasser, J.A., Gluck, M.E. & Geliebter, A. (2004). Impulsivity and test meal intake in obese binge eating women. *Appetite*, 43, 303-307.

Ng, S.P., Korda, R., Clements, M., Latz, I., Bauman, H., Liu, B. et al. (2011). Validity of self-reported height and weight and derived body mass index in middle-aged and

- 495 elderly individuals in Australia. *Australia and New Zealand Journal of Public Health*,  
 496 35(6), 557-63.
- 497 O'Connor, B.P. (2000). SPSS and SAS programs for determining the number of components  
 498 using parallel analysis and Velicer's MAP test. *Behaviour Research Methods*,  
 499 *Instruments & Computers*, 32(3), 396-402.
- 500 Ouwens, M.A., van Strein, T. & van der Staak, C.P.F. (2003). Tendency toward overeating  
 501 and restraint as predictors of food consumption. *Appetite*, 40: 291-298.
- 502 Papiés, E.K., Strobe, W., & Aarts, H. (2008). Healthy Cognition: Processes of self-regulatory  
 503 success in restrained eating. *Personality and Social Psychology Bulletin*, 34(9), 1290-  
 504 1300.
- 505 Patton, J.H., Stanford, M.S. & Barratt, E.S. (1995). Factor structure of the Barratt  
 506 Impulsiveness Scale. *Journal of Clinical Psychology*, 51, 768-774.
- 507 Pedram, P., Wadden, D., Amini, P., Gulliver, W., Randell, E., Cahill, F., Vasdev, S.,  
 508 Goodridge, A., Carter, J.C., Zhai, G., Ji, Y. & Sun, G. (2013). Food Addiction: Its  
 509 prevalence and significant association with obesity in the general population. *PLoS*  
 510 *ONE* 8(9): e74832.
- 511 Preacher, .J. & Hayes, A.S. (2008). Asymptotic and resampling strategies for assessing and  
 512 comparing indirect effects in multiple mediator models. *Behaviour Research Methods*,  
 513 40(3), 879-891.
- 514 Price, M., Higgs, S. & Lee, M. (under review). Snack Intake is Reduced Using an Implicit  
 515 High Construal Level Cue. *Health Psychology*.



- Pursey, K., Burrows, T.L., Stanwell, P., & Collins, C.E. (2014). How accurate is web-based self-reported height, weight and body mass index in young adults? *Journal of Medical Internet Research*, 16(1), e4.
- Snoek, H.M., Engels, R.C.M.E., van Strien, T. and Otten, R. (2013). Emotional, external and restrained eating behaviour and BMI trajectories in adolescence. *Appetite*, 67, 81-87.
- Stanford, M.S., Mathias, C.W., Dougherty, D.M., Lake, S.L., Anderson, N.E. and Patton, J.H. (2009). Fifty years of the Barratt Impulsiveness Scale: An update and review. *Personality and Individual Differences*, 47, 385-395.
- Stevens, J.P. (2002). *Applied multivariate statistics for the social sciences* (4<sup>th</sup> Ed.). Hillsdale, NJ: Erlbaum.
- Vainik, U., Dagher, A., Dube, L. & Fellows, L.K. (2013). Neurobehavioural correlates of body mass index and eating behaviours in adults: A systematic review. *Neuroscience and Biobehavioral Reviews*, 37: 279-299.
- Vainik, U., Neseliler, S., Konstabel, K., Fellows, L.K., and Dagher, A. (in press). Eating traits questionnaires as a continuum of a single concept. Uncontrolled eating. *Appetite*, 2015.
- van der Laan, L.N. and Smeets, P.A.M. (2015). You are what you eat: a neuroscience perspective on consumers' personality characteristics as determinants of eating behaviour. *Current Opinions in Food Science*, 3, 11-18.
- van Strien, T., Frijter, J.E.R., Bergers, G.P.A., & Defares, P.B. (1986). The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *Eating Disorders*, 5(2): 295-315.

- Westenhoefer, J., Broeckmann, P., Munch, A.K. & Pudel, V. (1994). Cognitive control of eating behaviour and the disinhibition effect. *Appetite*, 23, 27-41.
- Whiteside, S.P. & Lynam, D.R. (2001). The five factor model and impulsivity: using a structural model of personality to understand impulsivity. *Personality and Individual Differences*, 30, 669-689.
- Yeomans, M.R. & Coughlan, E. (2009). Mood-induced eating. Interactive effects of restraint and tendency to overeat. *Appetite*, 52, 290-298.
- Ziaudeen, H. & Fletcher, P.C. (2013). Is food addiction a valid and useful concept? *Obesity Reviews*, 1. 19-28.

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558 Figure 1: Predicted BMI at high and low levels ( $\pm 1$  SD) of FRR (Food reward responsivity)  
559 component scores and BIS11 (Barratt Impulsiveness Scale) total scores.

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561 Figure 2: Predicted BMI at high and low levels ( $\pm 1$  SD) of DR (Dietary restriction)  
562 component scores and BIS11 (Barratt Impulsiveness Scale) scores.

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Table 1: Sample Characteristics and Questionnaire Reliability.

Characteristic/Measure	Mean (SD); Range	Cronbach Alpha
Gender	M:F 105:366	
Age (years)	27.4 (10.2); 18-73	
BMI <sup>a</sup>	24.2 (4.77); 15.3-43.6	
DEBQ <sup>b</sup> Dietary Restraint	2.82 (.98); 1-5	.93
DEBQ <sup>b</sup> External Eating	3.11 (.68); 1-5	.85
DEBQ <sup>b</sup> Emotional Eating	2.49 (.84); 1-5	.92
TFEQ <sup>c</sup> Cognitive Restraint	54.6 (16.4); 21.4-96.4	.81
TFEQ <sup>c</sup> Uncontrolled Eating	57.7 (14.7); 25-100	.85
TFEQ <sup>c</sup> Emotional Eating	58.1 (18.5); 25-100	.75
PFS <sup>d</sup> Available	2.48 (1.08); 1-5	.89
PFS <sup>d</sup> Present	3.14 (1.04); 1-5	.84
PFS <sup>d</sup> Tasted	2.88 (.89); 1-5	.79
EES <sup>e</sup> Anger/frustration	21.2 (7.88); 11-50	.87
EES <sup>e</sup> Anxiety	17.9 (6.07); 9-40	.78
EES <sup>e</sup> Depression	14.8 (4.47); 5-25	.74
YFAS <sup>f</sup> symptom count	1.96 (1.46); 0-7	.62
YFAS <sup>f</sup> sum-score	18.8 (10.7); 1-62	.87
BIS <sup>g</sup> Motor	23.6 (4.8); 13-43	.70
BIS <sup>g</sup> Attention	17.6 (3.73); 9-30	.68
BIS <sup>g</sup> Non-planning	25 (5.16); 13-41	.74
BIS <sup>g</sup> Total	66.1 (11); 39-113	.84

<sup>a</sup>BMI (body Mass Index); <sup>b</sup>DEBQ (Dutch Eating Behaviour Questionnaire); <sup>c</sup>TFEQ (Three Factor Eating Questionnaire – Short form); <sup>d</sup>PFS (Power of Food Scale); <sup>e</sup>EES (Emotional Eating Scale); <sup>f</sup>YFAS (Yale Food Addiction Scale); <sup>g</sup>BIS (Barratt Impulsiveness Scale – Second order sub-scale and total scores).

Table 2: Bivariate correlation matrix (Pearsons r) for the questionnaire sub-scales included in the study.

Variable	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. BMI <sup>a</sup>	.10	.04	.11	.12	.16	.03	.12	.16	.06	.15	.12	.15	.15	.26	.27	.13	.06	.04	.10
2. EESaf <sup>b</sup>		.74	.63	.52	.48	.40	.54	.11	.47	.71	.01	.32	.39	.45	.47	.17	.34	.16	.26
3. EESanx <sup>c</sup>			.59	.45	.44	.35	.47	.03	.43	.67	-.06	.32	.39	.35	.40	.14	.27	.11	.20
4. EESdep <sup>d</sup>				.55	.55	.41	.58	.12	.50	.77	.02	.34	.52	.40	.48	.12	.21	.14	.19
5. PFSav <sup>e</sup>					.70	.62	.91	.14	.60	.56	-.01	.52	.39	.51	.61	.22	.32	.16	.28
6. PFSpres <sup>f</sup>						.62	.87	.02	.64	.54	-.12	.43	.35	.46	.54	.20	.35	.18	.29
7. PFStast <sup>g</sup>							.84	.06	.52	.40	-.06	.34	.28	.35	.42	.13	.25	.08	.18
8. PFStotal <sup>h</sup>								.09	.67	.58	-.06	.50	.39	.51	.61	.22	.35	.16	.29
9. DEBQrest <sup>i</sup>									-.02	.16	.78	.01	.04	.12	.28	.04	-.04	-.16	-.07
10. DEBQext <sup>j</sup>										.56	-.16	.54	.33	.44	.52	.25	.35	.24	.34
11. DEBQem <sup>k</sup>											.02	.43	.54	.50	.57	.19	.32	.16	.27
12. TFEQcr <sup>l</sup>												-.12	-.02	-.02	.12	-.04	-.12	-.25	-.18
13. TFEQue <sup>m</sup>													.54	.41	.42	.26	.27	.21	.30
14. TFEQee <sup>n</sup>														.33	.37	.14	.18	.11	.17
15. YFAS <sup>o</sup>															.83	.25	.34	.21	.32
16. YFAS <sup>p</sup>																.27	.37	.23	.35
17. BISmotor <sup>q</sup>																	.48	.46	.82
18. BISatt <sup>r</sup>																		.46	.77
19. BISnp <sup>s</sup>																			.83
20. BIStotal <sup>t</sup>																			

All values for correlates of BMI are controlled for age and gender. <sup>a</sup>BMI (Body Mass Index); <sup>b</sup>EESaf (Emotional Eating Scale – anger/frustration); <sup>c</sup>EESanx (Emotional Eating Scale – anxiety); <sup>d</sup>EESdep (Emotional Eating Scale – depression); <sup>e</sup>PFSav (Power of Food Scale – available); <sup>f</sup>PFSpres (Power of Food Scale – present); <sup>g</sup>PFStast (Power of Food Scale – tasted); <sup>h</sup>PFStotal (Power of Food Scale – Total score); <sup>i</sup>DEBQrest (Dutch Eating Behaviour Questionnaire – dietary restraint); <sup>j</sup>DEBQext (Dutch Eating Behaviour Questionnaire – external eating); <sup>k</sup>DEBQem (Dutch Eating Behaviour Questionnaire – emotional eating); <sup>l</sup>TFEQcr (Three Factor Eating Questionnaire – 18R – cognitive restraint); <sup>m</sup>TFEQue (Three Factor Eating Questionnaire – 18R – uncontrolled eating); <sup>n</sup>TFEQee (Three Factor Eating Questionnaire – 18R – emotional eating); <sup>o</sup>YFAS (Yale Food Addiction Scale – symptom count); <sup>p</sup>YFAS (Yale Food Addiction scale – sum-score); <sup>q</sup>BISmotor (Barratt Impulsiveness Scale , version 11, second order sub-scale – Motor Impulsivity); <sup>r</sup>BISatt (Barratt Impulsiveness Scale , version 11, second order sub-scale – Attentional Impulsivity); <sup>s</sup>BISnp (Barratt Impulsiveness Scale , version 11, second order sub-scale – Non-planning Impulsivity); <sup>t</sup>BIStotal (Barratt Impulsiveness Scale , version 11– Total Score).

$r_{\geq .13}$ :  $p < .05$ ;  $r_{\geq .16}$ :  $p < .01$ ;  $r_{\geq .20}$ :  $p < .0001$  (Bonferroni corrected for multiple correlations).

Table 3: Component matrix for eating behaviour questionnaire sub-scales.

Sub-scale	Component 1: Food Reward	Component 2: Dietary
	Responsivity	Restriction
EES anger/frustration <sup>a</sup>	<b>.77</b>	.06
EES anxiety <sup>a</sup>	<b>.72</b>	-.03
EES depression <sup>a</sup>	<b>.79</b>	.07
PFS available <sup>b</sup>	<b>.81</b>	.01
PFS present <sup>b</sup>	<b>.78</b>	-.13
PFS tasted <sup>b</sup>	<b>.66</b>	-.08
TFEQ cognitive restraint <sup>c</sup>	-.03	<b>.94</b>
TFEQ uncontrolled eating <sup>c</sup>	<b>.62</b>	-.16
TFEQ emotional eating <sup>c</sup>	<b>.62</b>	-.03
DEBQ dietary restraint <sup>d</sup>	.14	<b>.93</b>
DEBQ external eating <sup>d</sup>	<b>.76</b>	-.19
DEBQ emotional eating <sup>d</sup>	<b>.84</b>	.09
YFAS sum-score <sup>e</sup>	<b>.72</b>	.22

Extraction method used was Principle Component Analysis with 2 components extracted. <sup>a</sup>

EES (Emotional Eating Scale); <sup>b</sup> PFS (Power of Food Scale); <sup>c</sup> TFEQ (Three Factor Eating Questionnaire – 18R); <sup>d</sup> DEBQ (Dutch Eating Behaviour Questionnaire); <sup>e</sup> YFAS (Yale Food Addiction Scale – Sum-score). Component loadings <.4 suppressed, those >.4 in bold.

Table 4: PROCESS regression model (1) moderation output for FRR.

	coeff	t	SE	p	LLCI	ULCI
FRR	.64	2.87	.23	.004	.20	1.08
BIS11	.02	.58	.02	.564	-.03	.05
FRR x BIS11	.04	2.35	.02	.019	.01	.07
Age	.14	7.02	.02	.0001	.10	.18
Gender	-1.51	-3.01	.49	.003	-2.49	-.52

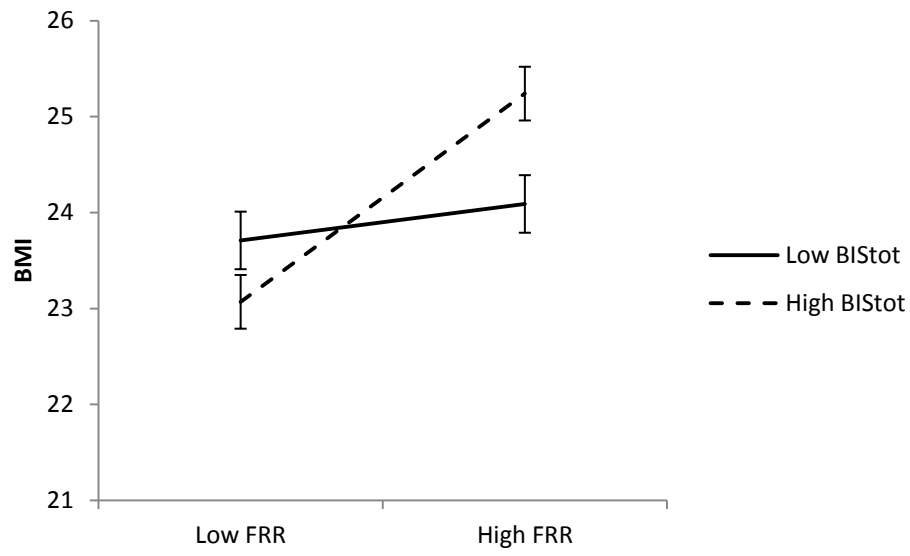
Moderation output for FRR (Food reward responsivity) component scores and BIS11 (Barratt Impulsiveness Scale) total scores controlling for Age and Gender. Coeff (unstandardized beta); SE (Standard Error); LLCI (Lower level confidence interval); ULCI (Upper level confidence interval).

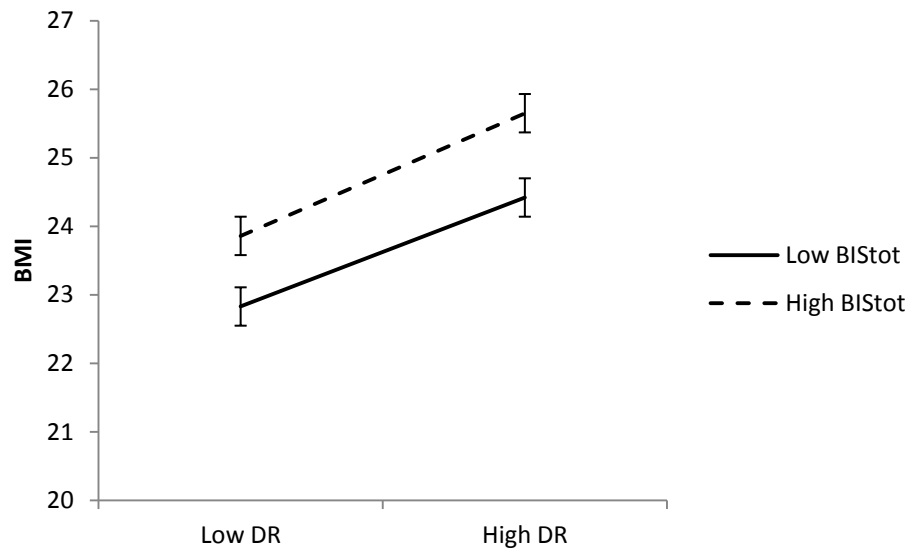
Table 5: PROCESS regression model (1) moderation output for DR

	coeff	t	SE	p	LLCI	ULCI
DR	.85	3.98	.21	.0001	.43	1.26
BIS11	.05	2.68	.02	.008	.01	.09
DR x BIS11	.01	.25	.02	.805	-.03	.04
Age	.14	6.64	.02	.0001	.10	.18
Gender	-1.81	-3.56	.51	.0004	-2.81	-.81

DR (Dietary restriction) component scores and BIS11 (Barratt Impulsiveness Scale) total scores controlling for Age and Gender. Coeff (unstandardized beta); SE (Standard Error); LLCI (Lower level confidence interval); ULCI (Upper level confidence interval).







*Highlights:*

Principle component analysis of widely used self-report eating behaviour measures.

Two components are supported: Food Reward Responsivity and Dietary Restriction.

Both components relate to BMI in a sample of males and females with a wide age range.

Food Reward Responsivity is moderated by impulsiveness but dietary restriction is not.

Results support a dual-system approach to overeating and obesity.